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Child Nutrition, Economic Growth, and the Provision of Health Care Services in Vietnam in the 1990s

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Abstract

Vietnam's rapid economic growth in the 1990s greatly increased the incomes of Vietnamese households, which led to a dramatic decline in poverty. Over the same period, child malnutrition rates in Vietnam, as measured by low height for age in children under 5, fell from 50 percent in 1992–93 to 34 percent in 1997–98. Disparities exist, however, between different regions, urban and rural areas, ethnicities, and income quintiles. This dramatic improvement in child nutrition during a time of high economic growth suggests that the nutritional improvements are due to higher household incomes. Glewwe, Koch and Nguyen investigate whether this causal hypothesis is true by estimating the impact of household income growth on children's nutritional status in Vietnam. Different estimation methods applied to the 1992–93 and 1997–98 Vietnam Living Standards Survey data find that growth in household expenditures accounts for only a small proportion of the improvements in children's nutritional status. The authors use data on local health facilities to investigate the role that they may have played in raising children's nutritional status in Vietnam.

This paper—a product of Macroeconomics and Growth, Development Research Group—is part of a larger effort in the group to study household welfare and poverty reduction in Vietnam. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Emily Khine, room MC3-347, telephone 202-473-7471, fax 202-522-3518, email address kkhine@worldbank.org. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. Paul Glewwe may be contacted at pglewwe@dept.agecon.umn.edu. February 2002. (50 pages)

Child Nutrition, Economic Growth and the Provision of Health Care Services in Vietnam in the 1990s

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I. Introduction

Child malnutrition is pervasive in almost every low income country. Among all developing countries, about 30% of all children under age 5 have abnormally low weight given their age (UNDP, 1998). For the least developed countries, this figure rises to 39%. Most economists would agree that economic growth can reduce child malnutrition in these countries. However, the size of this impact is uncertain and probably varies across countries. If the impact is small, policymakers will need to look for health policies that have a larger impact on children's nutritional status.

Child nutrition is a key issue Vietnam. It is one of the world's poorest countries, with an annual per capita GNP of about $370 in 1999. It has a very high level of child malnutrition; in 1993 50% of Vietnamese children under age 5 were stunted (abnormally low height given their age), although the situation has improved since that time. The role of economic growth in improving children's nutritional status is particularly relevant for Vietnam because it had very rapid economic growth in the 1990s. Its annual rate of real economic growth since 1988 has been about 8%, or about 6% in per capita terms, yet at the same time it remains a very poor country with high rates of child malnutrition.

This paper has two objectives. The first is to estimate the impact of economic growth on child nutrition in Vietnam, using data from two household surveys recently completed in Vietnam: the 1992-93 and the 1997-98 Vietnam Living Standards Surveys. A recent study of child nutrition in Vietnam, based on the 1992-93 data, found only a weak relationship between household income and child nutrition (Ponce, Gertler and Glewwe, 1998). This suggests that Vietnam's rapid economic growth in the 1990s had little impact on children's nutritional status, yet the 1997-98 data show that the incidence of stunting (low height for age) for children under 5 declined from 50% in 1992-93 to 34% in 1997-98. Given this apparent contradictory evidence, this paper seeks to clarify the role of economic growth.

One way to reconcile these findings is to investigate whether other factors, such as new public health policies, improved child nutrition in the 1990s. Thus the second objective of this paper is to examine the impact of various health programs on child nutrition. A very rich analysis is possible because the 1997-98 household survey contains data on health infrastructure that were not collected in the 1992-93 survey.

This paper is organized as follows. Section II presents some basic information about child nutrition and economic growth in Vietnam in the 1990s. The data used and the analytical framework are discussed in Section III. Estimates of the impact of household income on child nutrition are given in Section IV, and estimates of the impact of health programs and health prices are presented in Section V. Section VI briefly summarizes the results and provides several concluding comments.

II. Child Nutrition and Economic Growth in Vietnam in the 1990s

This section presents data on the nutritional status of Vietnamese children in the 1990s, and on Vietnam's economic performance during that decade. Before examining the data, it is useful to discuss how to measure children's nutritional status.

A. Measurement of Children's Nutritional Status. The nutritional status of children can be assessed using data on their age, sex, height and weight. In particular, such data can be used to calculate three indicators of children's nutritional status: 1) stunting (low height-for-age), 2) wasting (low weight-for-height) and 3) underweight (low weight-for-age). Each indicator describes different aspects of malnutrition.

Stunting is defined as growth in a child's height that is low compared to the growth in height of a reference healthy population. Slow growth in height over long periods of time causes children to fall further and further behind the height of the reference population. Thus stunting is a *cumulative* indicator of slow physical growth. In developing countries stunting is caused primarily by repeated episodes of diarrhea, other childhood diseases, and insufficient dietary intake.

In contrast, wasting is an indicator of current malnutrition, which leads to weight loss. Thus it indicates *current* nutritional problems, such as diarrhea, other childhood diseases, and insufficient dietary intake. While stunting is usually not reversed – children who become stunted typically remain so throughout their lives and thus never "catch up" – the weight loss associated with wasting can be restored quickly under favorable conditions.

The third indicator, underweight, can reflect stunting, wasting, or both. Thus it does not distinguish between long-term and short-term malnutrition.

All three measures are commonly expressed in the form of Z-scores, which compare a child's weight and height with the weight and height of a similar child from a reference healthy population. More precisely, the stunting Z-score of a child i is the difference between the height of that child, H_i, and the median height of a group of healthy children of the same age and sex from the reference population, H_r, divided by the standard deviation of the height of those same group of children (same age and sex) from the reference population, SD_r:

$$Z - score = \frac{H_i - H_r}{SD_r}$$

Relatively short children have negative height for age Z-scores, and thus stunted children are commonly defined as those that have Z-scores of –2 or lower.

Z-scores for low weight for age (underweight) are calculated in the same way, using the weight of the child (instead of height) and the median weight (and standard deviation) of children of the same age and sex from a healthy reference population. Finally, Z-scores for wasting (low weight for height) are obtained by comparing the weight of the child with the median weight (and standard deviation) of children from the reference population who have the same height as that child. The reference population was selected by the National Center for Health Statistics (NCHS), in accordance with World Health Organization recommendations (WHO, 1983).

The two preferred anthropometric indices for the measurement of nutritional status of children are stunting and wasting, since they distinguish between long-run and short-run physiological processes (WHO, 1986). The wasting (low weight for height) index has the advantage that it can be calculated without knowing the child's age. It is particularly useful in describing the current health status of a population and in evaluating the benefits of intervention programs since it responds more quickly to changes in nutritional status than does stunting. A disadvantage of this index, however, is that it classifies children with poor growth in height as normal (Gibson, 1990). Stunting measures long-run social conditions because it reflects past nutritional status. Thus the WHO recommends it as a reliable measure of overall social deprivation (WHO, 1986).

B. Children's Nutritional Status in Vietnam. Young children that receive sufficient breastmilk, infant foods and "adult" foods grow quickly and attain their potential weight and height, unless disease or other illnesses intervene. In developing countries, children that fail to attain their potential growth typically suffer from inadequate dietary intake, illness, or both. During the first years of life, the single most important factor is the incidence of diarrhea. Children who are exclusively breastfed are much less likely to be exposed to pathogens that lead to diarrhea and other gastrointestinal diseases, and they also receive immunitive agents from breastmilk. Yet when weaning foods are introduced, typically in the first 3-6 months of life, infants are exposed to many pathogens that often lead to diarrhea and other diseases. This typical pattern is found in the 1992-93 survey data from Vietnam. Figure 1 shows that the incidence of diarrhea (in the four weeks preceding the interview) in the first 18 months of life steadily rises to about 6 % before declining to less than 1% among children age 3 years and older.

Repeated bouts of diarrhea interfere with human growth, leading to low weight gain. This is seen in the data on wasting in Figure 1. The incidence of wasting (defined as a weight for height Z-score below -2) is only about 2% among children age 0-5 months, who are still primarily breastfed. Yet wasting increases steadily during the first two years of life, peaking at about 11% for children age 18-23 months. For children 2 years and older wasting fluctuates around 5%; by this age wasting is more likely caused by inadequate food intake since diarrhea is relatively.

The long-run consequence of diarrhea, other illnesses and inadequate food intake is stunting (low height for age). As seen in Figure 1, stunting (defined as a height for age Z-score below –2) rises dramatically during the first two years of life, from about 14% for children age 0-5 months to 65% for children age 18-23 months, and then "settles down" to about 55% for children aged two to nine years. Thus Vietnamese children follow the typical pattern in that their worse bouts of malnutrition occur during the first two years of life, and as a consequence slightly more than half of them become stunted by age two and remain so for the rest of their childhood.

The previous paragraphs described the situation in the early 1990s. The situation in the late 1990s shows substantial improvements, at least in terms of stunting. Figure 2 shows the same general pattern that wasting and diarrhea peak in the second year of life, so that stunting again typically develops during the first two years of life, after which it remains relatively high. However, stunting in 1997-98 was less common than in 1997-98 for all age categories.

While Figures 1 and 2 demonstrate typical patterns of malnutrition and show that stunting declined during the 1990s, two anomalies stand out. First, diarrhea appears to have increased dramatically for almost all age groups. This apparent increase is spurious because the question was asked differently in the two surveys. In the 1992-93 survey each person was asked (or, for small children, parents were asked) whether they had been sick in the last 4 weeks and, if so, what illness they suffered from. This underestimates the incidence of diarrhea for two reasons. First, some people may think of diarrhea as "normal" and so would answer that they had not been sick during the past 4 weeks. Second, persons suffering from more than one illness in the past 4 weeks were allowed to report only one illness. Thus if a child had diarrhea and another illness, the other illness may have been reported instead of diarrhea. In the 1997-98 survey all individuals were asked directly whether or not they had had diarrhea in the past 4 weeks, which resulted in a much higher reported incidence of diarrhea.

The second anomaly is that wasting (low weight for height) appears to have increased, which is inconsistent with the dramatic decline in stunting. More specifically, the data show that, for each age category, average weight and height increased substantially between 1992-93 and 1997-98, both of which indicate that the nutritional status of Vietnamese children greatly improved in the 1990s. However, height increases were larger than weight increases, so that weight for height indicates increased wasting (low weight for height). This suggests that examining changes in weight for height over time may provide a misleading picture of changes in children's nutritional status when overall nutritional status increases rapidly. Similar contradictory results over time have been found in sub-Saharan Africa (Sahn, et al. 1999).

More information about the nature of malnutrition (as measured by stunting and wasting) is provided in Table 1. The first three columns present data from the 1992-93 survey. At that time the overall incidence of stunting for children age 0-60 months was about 50%, while the incidence of wasting was about 6%. Stunting was most prevalent in rural areas, affecting about 53% of the population, while only about one third of urban children (33%) were stunted. This is not surprising since real per capita expenditures in urban areas were almost double those of rural areas (1,899,000 vs. 990,000 Dong), as seen in the third column. The figures on wasting are somewhat surprising in that they are almost the some for urban and rural children (5.7% and 5.9%, respectively).

Regional rates of stunting and wasting are also instructive. Vietnam has seven regions. The two regions with the highest rate of stunting in 1992-93 were the Northern

Uplands and the North Central region. As one would expect, these two regions also had the lowest average per capita expenditures. Stunting was least common in the Southeast region, which includes the largest city in Vietnam (Ho Chi Minh City, formerly known as Saigon) and by far the highest per capita expenditures. This strong correlation of stunting and per capita expenditures is not found in the data on wasting. Wasting is most common in the Mekong Delta (7.7%) even though it had the second highest per capita expenditures. The North Central region had the lowest incidence of wasting (4.1%) despite having the second lowest per capita expenditures. Overall, there is no clear correlation between wasting and per capita expenditures, which casts doubt on its use as an indicator of nutritional status.

Columns 4-6 of Table 1 present information from the 1997-98 survey. Incomes increased in all regions (although deflated numbers are not presented) and the incidence of stunting declined by almost one third, from 50% to 35%. This decline is seen in both urban and rural areas, and in all seven regions. The region with the largest percentage increase in per capita expenditures – the Red River Delta, which moved from 4th highest to 2nd highest per capita expenditures – had the largest decline in stunting, from 54% to 27%.

In contrast, the wasting data are rather puzzling. Wasting increased in urban and rural areas of Vietnam and in all seven regions. It shows no clear relationship with income or with changes in income. Given that other indicators of child health also show improvement over this time period, for example the infant mortality rate dropped from 44 to 39 (World Bank, 2001), the rest of this paper will focus on the stunting data.

C. Vietnam's Economic Performance in the 1990s. In the 1980's Vietnam was one of the poorest countries in the world. A rough estimate of its GNP per capita in 1984, in

1984 U.S. dollars, is \$117. This would place it as the second poorest country in the world, barely ahead of Ethiopia and just behind Bangladesh (the poorest and second poorest countries in the world as reported in World Bank, 1986). By 1999, Vietnam's GNP per capita had increased to \$370 (1998 U.S. dollars), so that instead of being second to last it ranked 167 out of 206 countries (World Bank, 2000).

This rapid improvement in Vietnam's economic performance began in 1986, when a series of decrees transformed Vietnam from a planned to a market-oriented economy. In particular, the government dissolved state farms and divided agricultural land equally among rural households, removed prices controls, legalized buying and selling of almost all products by private individuals, stabilized the rate of inflation and opened up the economy to foreign trade. In the 1990s Vietnam was one of the ten fastest growing economies in the world, with an average real GDP growth of 8.4% per annum from 1992 to 1998.

This rapid economic growth has led to a dramatic decline in the rate of poverty, from 58% in 1992-93 to 37% in 1997-98 (World Bank, 1999). As seen in Table 1, it also appears to have led to large decreases in the rate of stunting among Vietnamese children. Are these dramatic increases in the incomes of Vietnamese households the main cause of the large decreases in stunting among young children? Table 2 provides a first glance of the evidence. For each survey, households were divided into five groups of equal size on the basis of their per capita expenditures. The first group, quintile 1, is the poorest. In 1992-93 about 59% of the children in that group were stunted. The second poorest group, quintile 2, had the same rate. Quintiles 3, 4 and 5 had steadily lower rates of 45%, 44% and 29%, respectively. The same pattern is seen in the 1997-98 survey; the incidence of stunting among the poorest quintile is 41% and steadily drops to 14% for the wealthiest quintile. This pattern, based on cross-sectional data, suggests that higher incomes reduce child malnutrition. In contrast, the data on wasting (low weight for height) show no such pattern, raising further doubts about the informational content of this nutritional indicator, at least in the Vietnam context.

Returning to the stunting data in Table 2, note that stunting rates decline over time within each quintile. This suggests that something else in addition to income growth was leading to reduced malnutrition in Vietnam in the 1990s. Yet these quintiles are not strictly comparable because the poorest 20% of the population in 1997-98 had a higher income than the poorest 20% in 1992-93. The last column in Table 2 adjusts for this difference, classifying households in the 1997-98 survey according to the quintile categories used in the 1992-93 survey. Even after this adjustment is made there are still dramatic declines in stunting for households in the same income group. This suggests that increased household income is not the only factor that improved the nutritional status of Vietnamese children. The rest of this paper will examine this phenomenon more formally.

III. Data and Analytical Framework

A. Data. This paper uses the 1992-93 and 1997-98 Vietnam Living Standards Surveys. The 1992-93 survey covered 4800 households, while the 1997-98 survey covered 6000 households. Both surveys are nationally representative. About 4300 households were interviewed in both surveys and thus constitute a large, nationally representative panel data set. In both surveys, the household questionnaire covered many different topics, including education, health (use of health care facilities and anthropometric measurements of all household members), employment, migration, housing, fertility, agricultural activities, small household businesses, income and expenditures, and credit and savings. In each year, community questionnaires were completed in rural areas (where about 80% of Vietnamese households live) and detailed price questionnaires were completed in both urban and rural areas. The 1997-98 survey also included health facility and school questionnaires.

These two surveys are well suited for examining the determinants of children's nutritional status. All household members, children and adults, were measured for height, weight and arm circumference. The vast amount of household information, including detailed income and expenditure data, reduces problems of omitted variable bias. The panel data allow for estimation that controls for unobserved household fixed effects. Finally, the 1997-98 data include a large amount of information on the prices of medicines and the types of medical services (and their costs) provided by local health care facilities.

B. Analytical Framework. The data presented in Section II show changes over time but cannot explain what caused those changes, or more generally what determines children's nutritional status. Such causal analysis is much more difficult and requires a clear analytical framework to avoid drawing false inferences from the data.

The starting point for thinking about the determinants of a child's nutritional status is a health production function, since nutritional status is a major component of child health. In general, a child's health status (H) is determined by three kinds of variables, health inputs (HI), the local health environment (E) and the child's genetic health endowment (ε):

$$H = f(HI, E, \varepsilon) \qquad (1)$$

The child's health endowment (ε) is defined as all genetically inherited traits that affect his or her health. It is exogenous (cannot be altered by the child or anyone else), but is rarely observed in any data. The local health environment (E) consists of the characteristics of the community in which the child lives that have a direct effect on his or her health, such as the prevalence of certain diseases and the extent of environmental pollution. It is also exogenous, although one could argue that it is endogenous to the extent that households migrate to areas with healthier environments or take measures to improve the local health environment (this issue will be discussed further below). Finally, there are a wide variety of health inputs (HI) that the household provides to the child, including prenatal care, breastmilk, infant formula, all other foods, medicines and medical care. In addition, the quality of the household's drinking water, toilet facilities and other hygienic conditions around the home can be treated as health inputs.

While researchers would often like to estimate a health production function, it is almost impossible to do so because one rarely has complete data on health inputs and the local health environment, and data on the child's genetic endowment is rarer still. This incompleteness may well lead to serious problems of omitted variable bias. Analysis is further complicated by the need to have this information not only for the current time period but for all past time periods of the child's life. A more practical alternative is to consider what determines health inputs and "substitute out" that variable from equation (1). In general, the health inputs that households choose for their children are determined by the household income level (Y), the education levels of both parents (MS and FS, for mother's schooling and father's schooling), their "tastes" for child health (η), the local health environment and the child's genetic health endowment:

$$HI = g(Y, MS, FS, \eta, E, \varepsilon) \qquad (2)$$

Note that family size and the presence of other siblings are not included as determinants of health inputs. They are excluded because they are clearly endogenous, and including endogenous variables can lead to biased estimates unless suitable estimation methods, such as instrumental variables, are used. Thus it is best to include in equation (2) only variables that are clearly exogenous. Of course, one could rightly claim that household income is endogenous; for example, parents may change their hours of work in response to the health status of their children. However, removing this variable from (2) would preclude estimation of the key relationship of interest in this paper, so it is retained. The approach used to deal with possible estimation biases from retaining this variable is discussed below.

Substituting (2) into (1) gives the basic equation that this paper attempts to estimate:

$$H = g(Y, MS, FS, \eta, E, \varepsilon) \qquad (3)$$

The child's height for age Z-score will be used as the indicator of child health, H. As mentioned above, both surveys have data on household income and expenditures. Household per capita expenditures will be used instead of household per capita income to measure Y, for two reasons. First, expenditure data are likely to be more accurate than income data (Deaton, 1997). Second, expenditure data are more likely to reflect a households "permanent income", which is more appropriate in this case because Y represents the household's income stream since the child was born, not just current income.

The remaining variables in equation (3) merit further comment. The schooling of each parent is provided in both surveys, even for children no longer living with one or both parents (9% of the children in the sample are not living with their father, and 2% are not living with their mother). However, parental tastes for child health, η, are difficult to ascertain and no attempt was made to do so in the Vietnamese surveys used here. Dropping this variable from the estimation altogether is risky; doing so would relegate it to the error term and it could be correlated with household income (which would lead to biased estimates of the impact of household income on child health). For example, some parents may be "irresponsible", which implies low tastes for child health and low income. This would lead to overestimation of the impact of income on child health. This paper uses three approaches to deal with this problem. First, dummy variables representing different ethnic and religious groups are included to approximate, albeit only partially, tastes for child health. Second, in some estimates instrumental variables are used for household per capita expenditures, which should eliminate some or perhaps even all of the bias due to correlation between income and unobserved tastes for child health. Third, some estimates presented below are based on panel data; if parental tastes can be specified as an additive fixed effect, that variable will be differenced out of the panel estimates.

The last two variables in (3) are the local health environment, E, and the child's innate healthiness, ε. The estimates presented in Section IV use community fixed effects to control for all differences across communities, including differences in the local health environment. In Section V, a different approach is used; data from the 1997-98 survey on local health conditions, medicine prices and the availability of medical services are used to explicitly measure the impact of the local health environment on child health. Finally, consider the child's genetic health endowment, ε. In the cross-sectional estimates, this is partially represented by the height of each parent (which reflects both "normal" variation in height that is not associated with health status and the innate healthiness of each parent) and by the sex of the child (since girls are typically healthier than boys, but note that this masks any sex discrimination taking place). In estimates using panel data, the average healthiness of each household's children is treated as a fixed effect and thus is differenced out.

The last issue to address is the problem that household income is endogenous, which raises the possibility of simultaneity bias. In general, households make decisions about their children's health at the same time that they make decisions about income earning activities, and these two decisions could be related. For example, parents whose children are chronically ill may decide to purchase costly medicines or medical services, and to do this some household members may work more hours to pay for those medicines. If so, ordinary least squares (OLS) estimates would tend to underestimate the impact of household income (expenditures) on child health because unobserved negative shocks to child health would be positively correlated with household income. Alternatively, households may reduce hours worked because of a child's illness, for example the mother may work fewer hours in order to spend more time caring for the child. In this case OLS would overestimate the impact of household income (expenditures) on child health.

Another problem with both household income and expenditure data is that they are often measured with random error, simply because it is difficult for households to report accurately their incomes and expenditures. As explained above, this paper uses household expenditures instead of household income because it is likely to be more accurate. However, even household expenditures may have a significant amount of measurement error, much of which will be random. This will lead to underestimation (attenuation bias) of the true impact of household expenditures on child health.

Instrumental variable methods can, in principle, remove the bias caused by either endogeneity or measurement error in the household expenditures variable. The difficulty is to find plausible instrumental variables, that is variables that are correlated with household income but uncorrelated with unobserved determinants of child health and uncorrelated with the measurement error in the household expenditure variable. Two plausible categories of instrumental variables are types of agricultural land allocated to the household and certain sources of non-labor income. In Vietnam, agricultural land is tightly controlled by the government, and markets for land simply do not exist in most rural communities (less than 3% of households in the 1992-93 survey reported that they had bought or sold land in the previous year). Thus households' land assets are unlikely to be influenced by children's health status. Similarly, some types of non-labor income are received regardless of children's health status. Thus the following instrumental variables are used for households' per capita expenditures: irrigated annual cropland, unirrigated annual cropland, perennial cropland, water surface (fish ponds), income from social funds, social subsidies, dowries, inheritances and lottery winnings. Finally, the existence of relatives (more specifically, children of household members) living overseas may also indicate an additional source of income; although the amount of remittances sent by such relatives may respond to child illnesses, the existence of such relatives is unlikely to be affected by those illnesses. Two such variables are used, overseas relatives in other Asian countries and overseas relatives in Western countries.

As will be seen below, while these instrumental variables have statistically significant predictive power they are rather weak in terms of the R^2 coefficient in the first-stage regressions. If the main problem is measurement error, as opposed to household expenditures being correlated with unobserved determinants of child health, then one could use household income as an instrumental variable for household per capita expenditures. In the regression results presented below, two sets of instruments are used, one without household income, which should be robust to both endogeneity and measurement error in the income variable, and another set that adds income, which is robust to measurement error but is invalid if household income is endogenous with respect to child health.

IV. Income Growth and Child Nutrition

This section presents estimates of equation (3). In all estimates the dependent variable is the child's height for age Z-score, and the sample includes only children age 0-60 months. Separate estimates are presented for urban and rural areas. For cross-sectional estimates, results are given for both 1992-93 and 1997-98. The cross-sectional estimates are presented first, followed by panel data estimates.

A. Cross-Sectional Estimates. Table 3 presents estimates of equation (3), the determinants of child malnutrition (as measured by height for age Z-scores), for urban areas of Vietnam in 1992-93. The first column presents OLS estimates, which are likely to suffer from omitted variable bias due to unobserved characteristics of local communities (such as the local health environment). OLS estimates may also be biased because they do not account for endogeneity or measurement error in the household expenditure variable. The second column of estimates includes community fixed effects, which avoids bias due to unobserved community characteristics as long as those variables enter equation (3) in a simple additive form without interaction terms with household or child level variables. Yet fixed effects estimates are not robust to endogeneity or measurement error in the expenditure variable. The third and fourth columns employ both fixed effects and instrumental variables for household expenditures. The third column does not use household income as an instrument, so it should be robust to both measurement error and endogeneity, while the fourth adds household income as an instrument and thus controls only for measurement error.

Although the OLS estimates in the first column are likely to be biased, it is useful to begin with them because the results for many variables change only slightly when other estimation methods are used. As one would expect given the data in Figures 1 and 2, the age of the child has a strong relationship to malnutrition as measured by stunting. In addition to a linear term (age in months), quadratic and cubic terms were added to allow for flexibility in this relationship. Mother's and father's height are both strongly and positively related to child health, which partially controls for unobserved children's health endowment but also reflects natural variation in height across a healthy population. For some mothers and fathers (4% of mothers and 16% of fathers), the height variable was missing. In this case the parent is assigned the average height and a dummy variable is added to indicate this type of observation.

In all the regressions in Table 3, girls in urban areas appear to be slightly healthier than boys, but this apparent advantage is never statistically significant. The impact of mothers' and fathers' schooling is usually not statistically significant, which is somewhat surprising, especially for mothers. One would think that better educated mothers are more able to care for their children's illnesses, ceteris paribus. Perhaps better educated women are also more likely to work outside the home, which could have negative consequences for their children's health, so that the net effect of mother's education is zero. Finally, there are few differences across ethnic and religious groups in urban areas (the omitted groups are Vietnamese and "no religion"), the two exceptions are that Protestants and households practicing religions other than Buddhism and Christianity had children who were significantly less healthy. Both groups are relatively rare in urban areas, and it is not clear what to make of this result; indeed the result for Protestants is based on a single child and so should be treated with caution. Since the focus of this paper is on the impact of household income and health care services, these apparent impacts of religion on child health will not be discussed further.

Turn finally to the impact of per capita household expenditures (expressed in natural logarithm) on child health. The OLS estimate is 0.493, which is fairly precisely estimated (the standard error of 0.108 yields a t-statistic is 4.56). This is higher than the estimate of 0.22 found by Ponce, Gertler and Glewwe (1998), but that study included older children (up to 9 years) and so the estimates are not strictly comparable.

Even if household expenditures were exogenous and measured without error, the OLS estimate of the corresponding coefficient is likely to be biased due to correlation between household income and unobserved community differences. The basic problem is that wealthier communities may have a better health environment, for example better sanitation and health care facilities. If these community characteristics have effects that are primarily additive, community fixed effects estimates will remove this bias. Such estimates are shown in the second column of Table 3. As expected, the impact of household per capita expenditures is smaller, falling from 0.493 to 0.388. Yet the impact of household expenditures on child health is still statistically significant (the standard error is 0.140, yielding a t-statistic of 2.77).

The last two specifications in Table 3 attempt to correct for endogeneity and measurement error in household expenditures. The third column presents estimates that instrument household expenditures using the land asset and non-labor income variables. Although these instrumental variables have strong explanatory power in the sense that they have a high F-statistic (41.39), they do not by themselves explain a large percentage of the variation of per capita household expenditures (the R^2 coefficient of a regression of the expenditure variable on the excluded instruments is only 0.08). Thus, although the coefficient on per capita expenditures does not change appreciably (it is 0.441), it is not statistically different from zero because the standard error has increased to 0.443. This imprecision implies that one can say almost nothing about the impact of household expenditures on child health in urban areas of Vietnam in 1992-93.

Somewhat higher precision can be obtained if one assumes that household expenditures are exogenous, so that the only estimation problem is measurement error. This allows one to use per capita income as an instrumental variable, which greatly increases the precision of the estimates. When this is done the coefficient rises slightly to 0.502. Although the standard error falls from 0.443 to 0.306, the coefficient is still quite imprecisely estimated and thus not significantly different from zero (t-statistic of 0.163). Note finally that the standard overidentification test (see Davidson and MacKinnon, 1993) suggests that the instrumental variables are uncorrelated with the residual, although the power of the test to detect this problem may not be very high. Overall, it is difficult to estimate with any precision the impact of household expenditures on children's nutritional status in urban areas of Vietnam in 1992-93 once one accounts for the possibility that the expenditure variable may be endogenous and may be measured with error.

Cross-sectional results for rural areas of Vietnam in 1992-93 are reported in Table 4. The age and parental height variables show the same patterns as in urban areas. As in urban areas, girls are somewhat healthier than boys, but the difference is not statistically significant. Mother's schooling has a marginally significant negative effect in the OLS results, but this counterintuitive finding disappears in the fixed effects and 2SLS estimates. Father's schooling has a significantly positive effect in the fixed effects results, but this is not seen in the other specifications. Most estimates regarding religious and ethnic groups are statistically insignificant, except that again Protestant children are more malnourished and, in some specifications, other ethnic minorities are more likely to be malnourished.

Focusing on the (log) household expenditure variable, the OLS results show a precisely estimated impact of 0.336 (the standard error is 0.072). As in urban areas, this figure declines when community fixed effects are introduced, to 0.185 (with a standard error of 0.92).

The third column in Table 4 specifies the expenditure variable as endogenous, using the land and non-labor income variables as instruments. The point estimate is quite large, at 0.724, but the precision of the estimate is quite low because the standard error increases to 0.437. This imprecision is not surprising because a regression of household expenditures on the excluded instruments alone yields an R^2 coefficient of only 0.060. When (log) per capita income is added as an instrument the coefficient drops to 0.500; although the standard error is smaller (0.206) this estimate is not quite significant at the 10% level (t-statistic of 1.64). Fnally, note that both 2SLS specifications easily pass the overidentification test.

The 1997-98 survey had a larger sample size, which may provide more precise estimates. The results for urban and rural areas are presented in Tables 5 and 6, respectively. Many results for urban areas in 1997-98 are similar to those for 1992-93. The age effects and parental height impacts are similar, although somewhat weaker, the sex of the child and parental schooling show no consistently significant effects, and the impacts of the religion variables are similar. The one change is that the Chinese and ethnic minority variables now have positive effects that are statistically significant at the 5% level, but this is of little interest for the purposes of this paper.

The OLS estimate of the impact of household expenditures is lower in 1997-98 than in 1992-93 (0.341 and 0.493, respectively), and the same holds when fixed effects are introduced (0.146 in 1997-98 vs. 0.388 in 1992-93). The first set of 2SLS estimates shows an effect very similar to that of 1992-93 (0.401 vs. 0.441), but neither is statistically significant from zero. If one assumes that household expenditures are exogenous, then household income is a valid instrumental variable (for purposes of controlling for measurement error), and one obtains a much more precise and indeed a statistically significant estimate of 0.674 (standard error of 0.226). Both 2SLS estimates for1992-98 easily pass the overidentification test.

In rural areas in 1997-98, again there are few differences in most variables. Turning to the variable of primary interest, household expenditures, the OLS and fixed effect estimates are quite similar across the two years. However, the first set of 2SLS estimates is very different: in 1992-93 the estimated impact was 0.724 while in 1997-98 it was –0.220.

Yet when one recalls that both of these estimates have very large standard errors (0.473 in 1992-93 and 0.593 in 1997-98) it is clear that the difference between them is not statistically significant (t-statistic of 1.36). The second set of 2SLS estimates, which adds household income as an instrumental variable, is closer to the estimates for 1992-93, with point estimates of 0.500 in 1992-93 and 0.203 in 1997-98. Again, neither of these is very precisely estimated (with standard errors of 0.305 and 0.335, respectively), so they are not significantly different from each other.

B. Panel Data Estimates. In principle, there are two ways to use panel data to estimate the impact of household expenditures on children's nutritional status in Vietnam. First, one could examine data on the same children over time, and estimate the impact of changes in income on changes in their height for age Z-scores. However, this is rather problematic because, as seen in Figures 1 and 2, stunting develops in the first two years of life, after which there is little change. Thus any child who was covered in the 1992-93 survey was already at least 5 years old in the 1997-98 survey, and the impact of the household's expenditure levels in the latter survey should have almost no effect on the stunting of those children because their stunting developed 3 or more years prior to the time of that survey.

The other possibility is pursued in this paper, which is to compare children five years or younger in the first survey to children who were five years or younger in the second survey. This can be done using panel data for those households in the panel data that had children of that age in both 1992-93 and 1997-98, which occurs for 1663 of the 4300 households in the panel data set. For households that had two or more children in this age range in either year (or both years), all variables used are averages over those children.

Before examining the estimates, a discussion of their usefulness is in order. Recall that parental tastes for child health (η) and the child's health endowment (ε) are unobserved variables that could be correlated with household income. One way to try to get around this problem is to use instrumental variables for income that are not correlated with these variables. The approach with panel data is somewhat different. Instead, one assumes that the impact of these variables on child health takes an additive form and that these additive components do not change over time. If so, *changes* in household income will be uncorrelated with these household fixed effects, so regressing changes in height for age Z-scores on changes in household expenditures (and other variables that may change over time) should eliminate bias due to these two types of unobserved household characteristics.

While this sounds like a promising approach, there are at least two problems with it. First, children's health endowments vary at the child level, not the household level, so that although a household's *average* child health endowment differences out, the variation across different children within the household does not, and this could (at least in principle) lead to biased estimates for the same reason that it would do so in OLS estimation of cross-sectional data. Second, regressing differences in variables on each other greatly exacerbates measurement error, as stressed in Deaton (1997). Thus one would like to find instrumental variables that can predict changes in household income over time. This excludes many of the instrumental variables used above. In this subsection we simply try one instrumental variable, changes in household income over time.

Table 7 presents panel data estimates for urban and rural areas. The only variables that change over time are the age and sex of the children and (log) per capita expenditures. The sex dummy variable has no significant impact in any of the regressions. The age variable is again specified in a flexible way, with linear, quadratic and cubic terms. The coefficients on these age terms are quite similar to those seen in Tables 3-6.

The three urban regressions (OLS, fixed effects and 2SLSFE) reveal a rather odd finding: negative point estimates for the impact of household expenditures on child health. However, note that the standard errors on these coefficients are very large (0.168, 0.185 and 0.920, respectively), which reflects the small sample size. Thus the positive estimates in Tables 3 and 5 are not necessarily inconsistent with these results. On the other hand, these standard errors are so large that little can be inferred from them.

In rural areas, the sample sizes are much larger. In the OLS and fixed effects estimates, the estimated impacts of household expenditures are very close to zero, and the standard errors are small enough (0.077 and 0.084) to exclude the point estimates in Tables 4 and 6 from the associated confidence intervals. However, recall that such differenced estimates may suffer from considerable attenuation bias due to increased bias due to measurement error, The final column of estimates in Table 9 uses household income to correct for measurement error in the household expenditures variable (but recall that this assumes that expenditures can be considered exogenous). The point estimate of 0.376 is much larger and comparable with estimates in Tables 6 and 8. Unfortunately, this point estimate also has a very large standard error (0.512), so even in rural areas the panel data estimates are probably too imprecise to add anything to what has been learned from the cross-sectional estimates.

C. Impact of Income Growth on Child Nutrition. Given the estimates in Tables 3-7, what can be said about the impact of Vietnam's economic growth on child nutrition?

More precisely, is the rapid increase in household incomes and expenditures the main cause of Vietnam's substantial decrease in child stunting?

This question is examined in Table 8, which shows changes in mean height for age Z-scores and in the percent of children who are stunted from 1992-93 to 1997-98. The first three lines of the table show the actual changes, for rural and urban areas separately, while the rest of the table uses the estimated impacts of household expenditures from Tables 3-7 to examine how much of the change was brought about by directly raising households' expenditure levels.

Table 8 shows that the mean height for age Z-score in urban areas of Vietnam increased by 0.56 standard deviations, while the mean in rural areas increased by 0.49 standard deviations. These increases are quite dramatic over a period of only five years; they correspond to a drop of about 15 percentage points in the incidence of stunting in both urban and rural areas. Given the high rate of income growth over this time period, it is tempting to conclude that this large improvement in children's nutritional status is due to higher household income.

The remaining lines of Table 8 assess whether this conclusion is valid. For each estimator the predicted change in the mean height for age Z-score is given, which is simply the estimated coefficient of the impact of household expenditures multiplied by the change in (the log of) average household expenditures. For estimates based on cross-sectional data, the estimated impact used is a simple average of the 1992-93 and 1997-98 estimates. In addition, these estimated impacts are added to each child's Z-score in 1992-93 to see how they change the incidence of stunting (low height for age). Those calculations are reported in the third and fourth columns of Table 8.

The clear conclusion to draw from the results in Table 10 is that growth in household expenditures accounts for only a small proportion of the improvement of children's nutritional status in Vietnam from 1992-93 to 1997-98. In urban areas, the mean height for age Z-score increased by 0.58, but the highest predicted change among seven different specifications is only 0.28 (from the 2SLS specification with income as an instrumental variable), less than half the total amount. Similarly, the incidence of stunting dropped by 14.8 percentage points, but the predictions from the econometric estimates are much smaller, the highest one showing a drop of only 9.0 percentage points. The same conclusion holds even more forcefully for rural areas; the mean height for age Z-score dropped by 0.485 standard deviations but the largest predicted drop is only 0.09 standard deviations, and the incidence of stunting dropped by 15.0 percentage points while the largest predicted drop is only 3.2 percentage points.

Given the imprecision of the estimated impacts, it is useful to check the upper bound of the 95% confidence interval of the estimated impacts, since it is possible that even though the point estimates are low the actual change may still lie within that confidence interval. The mean changes in height for age Z-scores using the upper bounds of the 95% confidence intervals are shown in brackets in the first two columns of Table 8. In only two out of fourteen cases does the actual change lie within that confidence interval. Thus one must conclude that growth in household incomes accounts for only a proportion, and probably a rather small proportion, of the improvement in children's nutritional status in Vietnam during the 1990s.

V. Health Programs and Child Nutrition

The results of Section IV strongly suggest that something else happened in Vietnam in the 1990s that reduced child nutrition. One possibility is that health services in Vietnam dramatically increased in their quantity, or quality, or both. This section reviews changes in the quantity and quality of health services in Vietnam, and then uses the 1997-98 VNLSS data to examine the impact of health services on child nutrition in rural areas.

A. Growth in Health Programs

The community and price questionnaires in 1992-93 and 1997-98 surveys have some information that can be used to examine expansion in health services in the 1990s in Vietnam. In general, publicly provided services did not expand their coverage in the 1990s (World Bank, 2001). However, the economic reforms allowed private individuals to sell medicines and provide health services. Each survey collected price data on a variety of commonly used medicines in Vietnam. The medicines covered changed in the two surveys, so that only ampicillin and penicillin prices were collected in both surveys. No price data were recorded if communities did not have available a given medicine, which in principle allows one to use the price data to see whether allowing private individuals to sell medicines increased their availability.

In urban areas in 1992-93 all 30 communes in the sample had price data for all medicines, while in rural areas only 3 of 120 communes reported no data for ampicillin prices and only 10 of 120 reported no data for penicillin prices. This "completeness" of the 1992-93 price data imply that it is not possible to use the price data to check for increased availability of these medicines from private providers. While one may think that this demonstrates that medicine availability did not improve because these medicines were already available almost everywhere, this is not necessarily the case since the distance traveled to obtain the medicine may have decreased. Thus, the only conclusion is that the price data from the two surveys are not very informative about changes in the availability of medicines.

The other way to check the survey data to see if the availability of medicines and medical services from private providers increased in the 1990s is to examine the community questionnaires in both surveys, which asked about distances from the communities to various medical facilities, including the distance to the nearest private pharmacy. Using the panel data, distance information in both years is available from 111 of the 120 rural communes covered in the 1992-93 survey. In 67 communes (60%), the distance to the nearest private pharmacy did not change during the two surveys, while for 18 communes (16%) the distance increased and for 27 communes (24%) the distance decreased. There may be some noise in these data, but overall the data suggest that the distance to the nearest private pharmacy was more likely to decrease than to increase. In fact, among the 18 communes where the distance increased the median distance of the increase was 3 kilometers, while in the 27 that experienced a decrease the median distance dropped by 7 kilometers.

B. Econometric Estimates

The 1997-98 VNLSS price questionnaire collected detailed data on the prices of nine medicines in both urban and rural areas. In addition, in rural areas the community questionnaire collected data on the distance from the sampled communes to 14 different kinds of health facilities or health service providers. That questionnaire also collected information from community respondents on specific illnesses that were common to the community and on reported problems with the commune health center.

Commune health centers are the "first line of defense" in the Vietnamese health care system. Almost every rural commune has a commune health center; of the 156 communes in the 1997-98 VNLSS for which community data were collected, only two did not have their own commune health center (and in both cases there was a commune health center within five kilometers). The 1997-98 VNLSS administered a Commune Health Center Questionnaire in 155 of the 156 communes in the rural areas covered by that survey. That questionnaire collected information on: a) the number of medical staff (doctors, physician assistants, nurses and nurse's aides); b) hours of operation; c) number of beds; d) the availability of 11 kinds of medical services; e) the availability of electricity, "clean water" and a "sanitary toilet"; f) 13 different types of medical equipment, ranging from thermometers to laboratories; g) the availability and prices of nine kinds of medicines (the same ones collected in the price questionnaire); and h) fees for five kinds of services, and some information on how often those fees are waved for different types of people.

In this subsection we add community level variables that are relevant for child health to see whether they any have explanatory power as determinants of child health. Because there are so many variables, and they vary only at the level of the community (and there are only 156 communities in our rural sample), we do not add them all at once, but start with the most basic and then add other sets of variables (sometimes in the form of an "index") to see what explanatory power they have.

We begin with the data on medicine prices. Of the nine types of medicine available, the one most relevant for child nutrition is oral rehydration salts. Other potentially relevant medicines are the antibiotics ampicillin and penicillin, paracetemol (to reduce fevers), iron tablets and vitamin A tablets. Unfortunately, these price data are very noisy, as seen in the first six rows of Table 9. Although prices were supposed to be collected for a given number of doses for a particular brand, it is likely that some observations are for a different number of doses, or perhaps for a different brand. The variation in the price of iron tablets is particularly egregious, the standard deviation is nearly twice as large as the mean, and the maximum value is 20 times larger than the median value. To see whether these data had any explanatory power, the OLS regression in Table 6 (for rural areas in 1997-98) was re-estimated five times, each time adding one of the price variables for each of these five types of medicine (iron tablet prices were deemed too noisy to be used). In all cases, the point estimates were very close to zero and were far from any statistical significance. As an example, consider the medicine most likely to have an effect, namely oral rehydration salts (which also displayed the least amount of noise in the data). While the price of oral rehydration salts had the expected negative sign, it had a t-statistic of only 0.83 and thus was not statistically different from zero.

Another "price" of medical care is the distance to nearby health facilities. Although the distance to commune health centers is trivial, those centers are not equipped to handle the most serious medical problems, so that seriously ill individuals must go to a hospital in a district or provincial capital, or perhaps to some other kind of health facility (including private health facilities). Of the 13 other types of health facilities or health service providers considered in the commune questionnaire, four had missing data for nearly a third or a fourth of the observations (private nurse, medicine peddler, midwife and oriental/traditional doctor) and thus were not considered. For the remaining nine, the same procedure used with the medicine data was used for the distance data. For six types of facilities (family planning center, polyclinic, district hospital, other hospital, private doctor and private physicians assistant) no significant relationship was found. However, for three types of health facilities, provincial hospital, state pharmacy and private pharmacy, a significant negative effect (at the 5% level) was found.

The first column of Table 10 presents the results when all three distance variables are added simultaneously. The distance to the nearest provincial hospital is statistically significant at the 10% level, with a coefficient of –0.0023. The distance to the nearest state pharmacy is not statistically significant; it has a coefficient of –0.0022 and a standard error of 0.0019. Finally, the distance to the nearest private pharmacy is statistically significant at the 1% level, with a coefficient of –0.0158). Despite the statistical significance of two of the distance variables, the policy significance of the estimated impacts is not particularly large. Reducing by one half the current mean value of the distance to the nearest provincial hospital implies an improvement in children's z-scores of about 0.044, and halving the distance to the nearest private pharmacy implies an improvement of only 0.025.

The next set of variables to consider are those from the community questionnaire on local health problems and problems with the commune health center. Five illnesses cited seem relevant for small children: malaria; respiratory illnesses (other than tuberculosis), childhood illnesses (diphtheria, whooping cough, measles, polio, tetanus, and encephalitis), diarrhea and "child malnutrition". Using the same procedure described above, only respiratory illnesses approached statistical significance, with a point estimate of –0.130 and a t-statistic of –1.34. Even less statistical significance was seen in the variables citing problems with local health facilities (lack of equipment and supplies, lack of medicines, inadequate staff, inability of staff to provide services, inadequate training opportunities, and lack of sanitation). None of these variables had a t-statistic greater than 1.3 when added to the regression.

Finally, turn to the data from the health facility questionnaire. The number of staff in the clinic, divided by the population of the commune, never had any explanatory power, either separately or as a group. The same is true of weekly hours of operation and number of beds (divided by the commune population). Of the 11 kinds of services offered, one was offered by all clinics in the sample (immunizations), one was offered by all but two of the communities (prenatal care), and two appear to be irrelevant for child nutrition (eye exams and dental exams). Of the remaining seven, three are closely tied to child health (obstetrics, child health exams and education on nutrition), two concern birth control (IUD insertion and abortion), and two are very general (eastern medicine and "simple operations"). The last four had no explanatory power when entered individually. Neither did the three that are most closely tied to child health. In addition, putting all of the variables together into a general health services index had no explanatory power either.

Next consider the three general variables concerning amenities at the facility; electricity, "clean water" and "sanitary toilet". Of these, lack of a sanitary toilet and lack of electricity both had significantly negative effects on child health when added separately, while the clean water variable had no effect. A regression adding these two variables is shown in the second column of Table 10. The electricity variable loses statistical significance while the toilet variable is still significantly negative. The policy significance of lacking a sanitary toilet is much larger than that of the distance variables; taking the coefficient at face value implies that remedying this deficiency will increase the typical child's height for age z-score by 0.15 points.

The next set of variables examined are the 13 equipment variables. There are so many that the best thing to do is to develop an index. First we drop four variables with almost no variation: blood pressure monitor and stethoscope (only one commune did not have); and thermometer and laboratory (only three communes did not thermometers and only three had laboratories). We also drop two variables that have no clear relevance for child malnutrition, eye charts and "family planning equipment" (for abortions). This leaves seven variables for the general index: refrigerator, sterilizing equipment, delivery bed, microscope, examining bed, child growth chart and child scale.[1] The results after adding the equipment index is shown in the third column of Table 10. It has the expected positive sign but is not statistically significant (t-statistic of 1.24).

The last type of information in the commune health center questionnaire is data on the availability of drugs, the price of those drugs (if available), and the prices of common health services. The drug availability index ranges from 1 (not available) to 5 (always available). This variable was statistically significant for only one drug, oral rehydration salts, which had the expected positive impact with a t-statistic of 1.74). Turning to drug prices, missing data were a serious problem because prices were not recorded for commune centers that rarely or never had the medicine. Of the four for which price data were

[1] As an exploratory exercise, each piece of equipment was added by itself. The three that approached statistical significance were delivery beds, examining beds and child scales, with the expected positive sign and t-statistics ranging from 1.9 to 2.6. Since there are many other kinds of equipment that are not observed but may be correlated with specific observed equipment, it seemed best to combine all types of equipment into a single index.

available at almost all commune health centers, three had statistically significant effects: ampicillin, penicillin and oral rehydration salts (the fourth was parameticol, which is used to treat fevers). The prices of ampicillin and penicillin were highly correlated, and only ampicillin was retained because it had fewer missing values. An odd finding for both ampicillin and penicillin is that the sign was positive; higher prices improved child health. Finally, prices of three kinds of medical services were examined: general examination, birth and "injection". Only the injection price had a statistically significant impact, which was unexpectedly positive.

When all four statistically significant variables discussed in the previous paragraph (price of ampicillin, price of injection, and availability and price of oral rehydration salts) are added to the regression (not show in Table 10), only one retains statistical significance: the availability of oral rehydration salts has the expected negative sign. Because the sample size drops considerably due to missing data in all of these variables, only the oral rehydration salts variable is added in the regression shown in the last column of Table 10 (even then the sample size drops from 1411 to 1342). The impact of the index is statistically significant at the 5% level, with a parameter estimate of 0.110. Since this index ranged from 1 to 5, this estimate implies that a change from never being available to always being available raises child height for age Z-scores by 0.44 points, which almost the size of the increase in rural areas from 1992-93 to 1997-98 reported in Table 8. Note, however, that 84% of the commune health centers report that they already have this medicine available all the time, so the benefits of oral rehydration salts are already reaching most Vietnamese children.

VI. Summary and Conclusion

This paper has investigated the impact of household income growth, as measured by household expenditures, on child nutritional status in Vietnam in the 1990s. Vietnam was doubly fortunate in this decade: household incomes rose dramatically and children's nutritional status improved rapidly. While one may conclude that the former caused the later, the estimates presented here do not support such a conclusion. Using many different estimation methods, this paper has shown that the impact of household expenditures on children's nutritional status (as measured by height for age Z-scores) is not necessarily significantly different from zero. More specifically, the impact may well be positive, but it is not very large. In particular, none of the estimates is large enough to account for even half of the measured improvement in children's nutritional status from 1992-93 to 1997-98.

While some observers may argue that this finding casts doubt on the benefits of economic growth for children's health status, such a conclusion would be premature. This is because economic growth may lead to other changes in society, such as improved health care services. That is, economic growth should increase government budgets through higher tax revenues, some of which can then be used to provide better health care services. The question then becomes: What kinds of health projects are most effective at raising child (and adult) health? A first attempt at answering this question was made in Section V. The community level data on health services suggest that the distance to private pharmacies has a statistically significant, though not very large, negative effect on child nutrition. It also suggests that providing commune health centers with "sanitary toilets" and ample supplies of oral rehydration salts could have substantial positive impacts on child health in Vietnam.

These findings regarding community level health services are tentative; much more research is needed in Vietnam on the impact of the impact of different kinds of health care services and programs on children's nutritional status. A particularly crucial factor may be parents' health knowledge, especially mothers' health knowledge. A recent study of Morocco found that mothers' health knowledge was the main pathway by which mothers' education affects child health (Glewwe, 1999). In Vietnam, several new community programs supported by donor agencies focus on raising parents' health knowledge (see World Bank, 2000b). Such programs could lead to substantial improvements in children's nutritional status, but rigorous analysis is needed to test this hypothesis.

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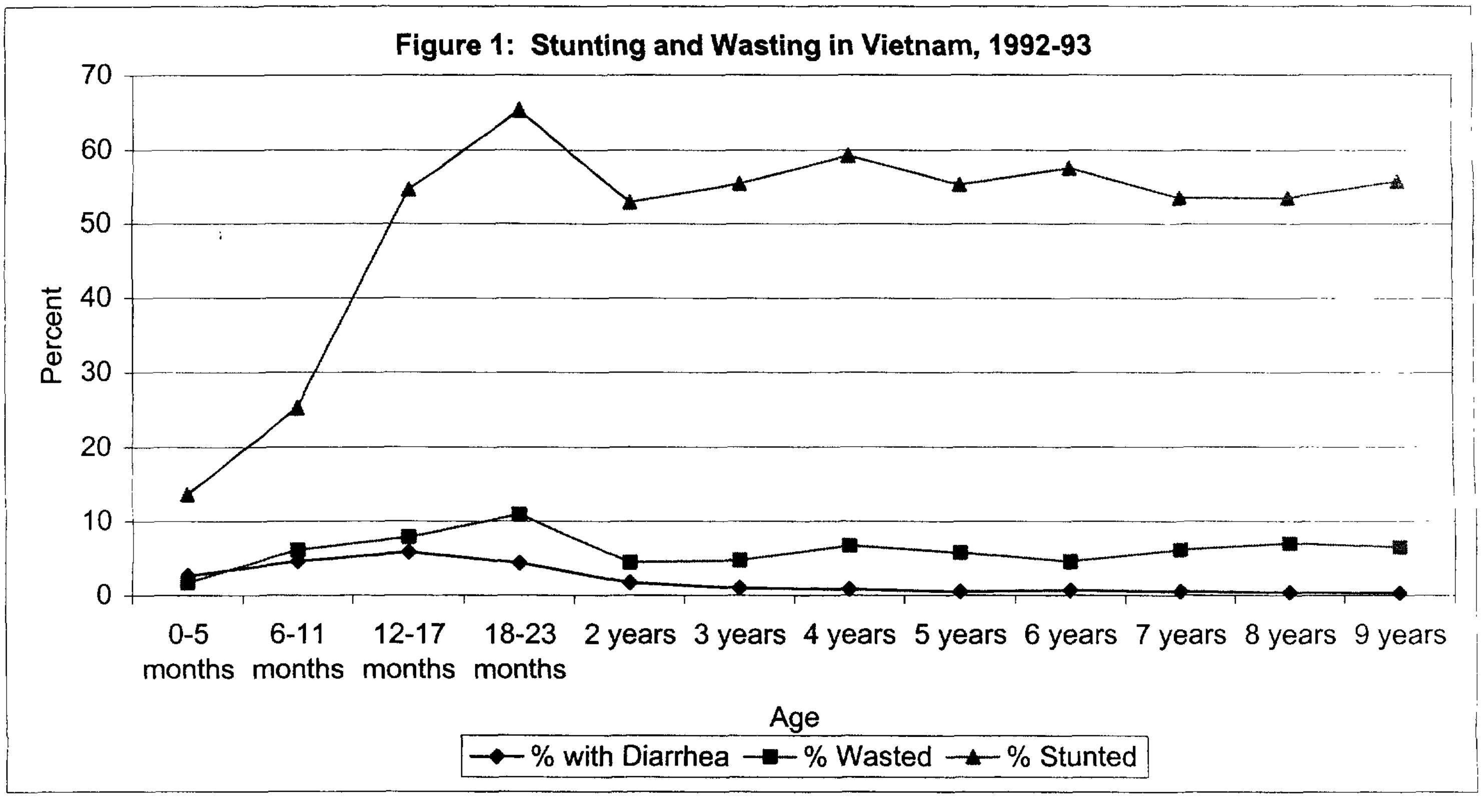

Figure 1: Stunting and Wasting in Vietnam, 1992-93
70
60
50
40
30
20
10
0
Percent
0-5 months
6-11 months
12-17 months
18-23 months
2 years
3 years
4 years
5 years
6 years
7 years
8 years
9 years
Age
% with Diarrhea
% Wasted
% Stunted

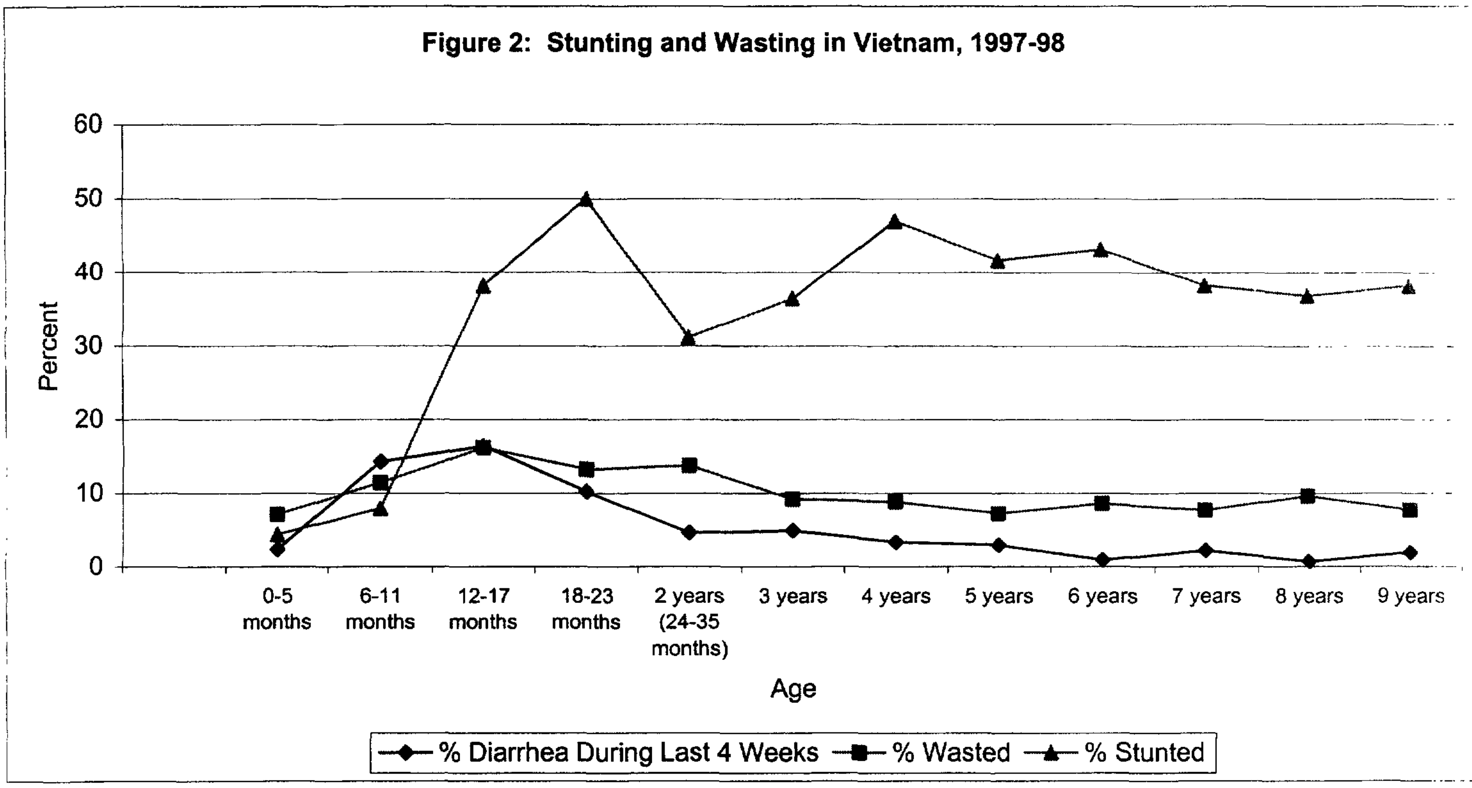

Figure 2: Stunting and Wasting in Vietnam, 1997-98
60
50
40
30
20
10
0
Percent
0-5 months
6-11 months
12-17 months
18-23 months
2 years (24-35 months)
3 years
4 years
5 years
6 years
7 years
8 years
9 years
Age
% Diarrhea During Last 4 Weeks
% Wasted
% Stunted

Table 1: Stunting and Wasting by Region, 1992-93 and 1997-98 (children 0-60 months)

	1992-93			1997-98		
	Stunting	**Wasting**	**Per Capita Expend.**	**Stunting**	**Wasting**	**Per Capita Expend.**
Northern Uplands	58.7%	6.2%	804	42.3%	9.8%	1593
Red River Delta	54.2	5.4	1049	26.6	11.0	2462
North Central	57.8	4.1	877	40.7	15.8	1716
Central Coast	46.5	5.5	1232	37.1	8.1	1959
Central Highlands	52.7	5.5	983	43.3	6.8	1855
Southeast	29.8	5.5	1754	17.8	7.3	4340
Mekong Delta	45.0	7.7	1333	33.5	2.3	2154
All Urban	33.2	5.7	1899	18.4	8.4	4099
All Rural	53.2	5.9	990	38.2	11.4	1816
All Vietnam	50.2	5.8	1128	34.6	10.8	2227

Note: Per capita expenditures are given in thousands of current Dong

Table 2: Malnutrition By Expenditure Quintiles, 1992-93 and 1997-98 (children 0-60 months)

	Stunting		
Quintile	**1992-92**	**1997-1998**	**1997-98 with 1992-93 Quintile**
1	58.6	41.3	45.0
2	59.1	42.1	38.6
3	45.3	32.6	41.6
4	44.4	27.5	34.0
5	29.2	14.2	18.5

	Wasting		
Quintile	**1992-92**	**1997-1998**	**1997-98 with 1992-93 Quintile**
1	5.4	13.2	15.0
2	5.5	12.4	12.1
3	6.9	10.0	12.5
4	5.9	5.3	9.2
5	5.8	9.0	7.2

Table 3: **Determinants of Child Malnutrition in Urban Areas, 1992-93**

	OLS	Fixed Effects	2SLSFE (1)	2SLSFE (2)	Means
Constant	-19.245***	-	-	-	1.00
	(2.62)				
Age (months)	-0.223***	-0.221***	-0.220***	-0.219***	31.5
	(0.34)	(0.038)	(0.039)	(0.037)	
Age^2	0.007***	0.007***	0.007***	0.007***	-
	(0.001)	(0.001)	(0.002)	(0.001)	
Age^3	-0.00007***	-0.00007***	-0.00007***	-0.00006***	-
	(0.00001)	(0.00002)	(0.00002)	(0.00002)	
Mother's height (cm)	0.051***	0.046***	0.046***	0.046***	153.0
	(0.010)	(0.012)	(0.012)	(0.012)	
Mother's height missing	0.905***	0.652**	0.666	0.721**	0.04
	(0.266)	(0.285)	(0.407)	(0.362)	
Father's height (cm)	0.051***	0.052***	0.052***	0.052***	162.4
	(0.012)	(0.013)	(0.013)	(0.013)	
Father's height missing	-0.252*	-0.257*	-0.257*	-0.251*	0.16
	(0.144)	(0.153)	(0.148)	(0.152)	
Female child	0.073	0.100	0.100	0.101	0.48
	(0.112)	(0.109)	(0.109)	(0.109)	
Log mother's years schooling	0.126	0.185*	0.180	0.162	1.95
	(0.098)	(0.105)	(0.132)	(0.128)	
Log father's years schooling	-0.114	-0.203**	-0.207*	-0.224*	2.09
	(0.100)	(0.92)	(0.118)	(0.122)	
Log per capita expenditures	0.493***	0.388***	0.441	0.502	7.34
	(0.108)	(0.140)	(0.443)	(0.308)	
Buddhist	-0.018	-0.207	-0.207	-0.204	0.30
	(0.129)	(0.158)	(0.164)	(0.162)	
Catholic	0.129	-0.114	-0.115	-0.121	0.14
	(0.215)	(0.327)	(0.331)	(0.337)	
Protestant	-1.992***	-2.356***	-2.346***	-2.306***	0.002
	(0.223)	(0.174)	(0.256)	(0.241)	
Other religion	-0.966***	-1.226	-1.221	-1.202	0.02
	(0.347)	(0.898)	(0.891)	(0.874)	
Chinese	-0.161	-0.612	-0.616	-0.631	0.11
	(0.218)	(0.401)	(0.405)	(0.405)	
Ethnic Minority	0.386	0.251	0.267	0.325	0.02
	(0.642)	(0.657)	(0.736)	(0.681)	
R^2	0.283	0.351	0.351	0.350	
Overidentification test (p-value)	-	-	0.284	0.364	
F-test on excluded instruments	-	-	41.39	36.29	
Observations	415	415	415	415	

Notes: 1. Standard errors (adjusted for sample design) in parentheses.

2. Statistical significance at 10, 5 and 1 percent levels indicated by 1, 2 and 3 asterisks, respectively.

3. Instrumental variables for (1) of 2SLSFE are: irrigated annual cropland, unirrigated annual cropland, perennial cropland, and water surface; income from social funds, social subsidies, dowries, inheritances and lottery winnings; and the existence of relatives in other Asian countries and in non-Asian countries. The estimates in (2) add per capita household income as an instrument.

Table 4: Determinants of Child Malnutrition in Rural Areas, 1992-93

	OLS	Fixed Effects	2SLSFE (1)	2SLSFE (2)	Means
Constant	-12.909***	-	-	-	1.00
	(1.283)				
Age (months)	-0.207***	-0.205***	-0.209***	-0.208***	30.9
	(0.021)	(0.022)	(0.023)	(0.022)	
Age^2	0.006***	0.006***	0.006***	0.006***	-
	(0.001)	(0.001)	(0.001)	(0.001)	
Age^3	-0.00005***	-0.00005***	-0.00005***	-0.00005***	-
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	
Mother's height (cm)	0.042***	0.040***	0.038***	0.039***	151.7
	(0.006)	(0.006)	(0.006)	(0.006)	
Mother's height missing	-0.013	0.018	0.002	0.009	0.03
	(0.114)	(0.219)	(0.215)	(0.215)	
Father's height (cm)	0.028***	0.023***	0.019**	0.021***	161.9
	(0.007)	(0.007)	(0.008)	(0.008)	
Father's height missing	-0.026	-0.007	0.004	-0.000	0.11
	(0.114)	(0.120)	(0.121)	(0.119)	
Female child	-0.084	-0.083	-0.079	-0.081	0.49
	(0.061)	(0.059)	(0.061)	(0.060)	
Log mother's years schooling	-0.086*	0.060	-0.029	0.008	1.63
	(0.050)	(0.055)	(0.086)	(0.073)	
Log father's years schooling	0.067	0.119**	0.034	0.069	1.82
	(0.058)	(0.060)	(0.090)	(0.076)	
Log per capita expenditures	0.336**	0.185**	0.724*	0.500	6.77
	(0.072)	(0.092)	(0.437)	(0.305)	
Buddhist	0.042	-0.050	0.006	-0.017	0.23
	(0.080)	(0.117)	(0.137)	(0.126)	
Catholic	-0.111	-0.220	-0.206	-0.212	0.09
	(0.125)	(0.136)	(0.139)	(0.140)	
Protestant	-0.248	-0.556***	-0.510***	-0.529***	0.01
	(0.157)	(0.058)	(0.091)	(0.078)	
Other religion	0.203	0.130	0.068	0.094	0.02
	(0.336)	(0.355)	(0.389)	(0.375)	
Chinese	0.076	0.297	0.144	0.208	0.01
	(0.250)	(0.343)	(0.384)	(0.370)	
Ethnic Minority	-0.322***	-0.238**	-0.170	-0.198*	0.19
	(0.093)	(0.114)	(0.129)	(0.119)	
R^2	0.196	0.257	0.242	0.252	
Overidentification test (p-value)	-	-	0.559	0.591	
F-test on excluded instruments	-	-	10.84	16.59	
Observations	2372	2372	2372	2372	

Notes: 1. Standard errors (adjusted for sample design) in parentheses.

2. Statistical significance at 10, 5 and 1 percent levels indicated by 1, 2 and 3 asterisks, respectively.

3. Instrumental variables for (1) of 2SLSFE are: irrigated annual cropland, unirrigated annual cropland, perennial cropland, and water surface; income from social funds, social subsidies, dowries, inheritances and lottery winnings; and the existence of relatives in other Asian countries and in non-Asian countries. The estimates in (2) add per capita household income as an instrument.

Table 5: Determinants of Child Malnutrition in Urban Areas, 1997-98

	OLS	Fixed Effects	2SLSFE (1)	2SLSFE (2)	Means
Constant	-15.028***	-	-	-	1.00
	(2.306)				
Age (months)	-0.140***	-0.115***	-0.121**	-0.127***	31.6
	(0.034)	(0.039)	(0.047)	(0.041)	
Age^2	0.004***	0.003**	0.003*	0.003**	-
	(0.001)	(0.001)	(0.002)	(0.001)	
Age^3	-0.00003***	-0.00002*	-0.00003	-0.00003**	-
	(0.00001)	(0.00001)	(0.00002)	(0.00001)	
Mother's height (cm)	0.038***	0.036***	0.034**	0.033**	152.5
	(0.013)	(0.013)	(0.015)	(0.013)	
Mother's height missing	-0.064	-0.080	-0.033	0.018	0.02
	(0.417)	(0.361)	(0.406)	(0.373)	
Father's height (cm)	0.041***	0.036***	0.034***	0.032***	162.5
	(0.010)	(0.011)	(0.012)	(0.011)	
Father's height missing	-0.140	-0.225	-0.206	-0.185	0.12
	(0.181)	(0.186)	(0.203)	(0.200)	
Female child	0.073	0.092	0.082	0.070	0.49
	(0.126)	(0.137)	(0.146)	(0.144)	
Log mother's years schooling	0.181**	0.138	0.059	-0.026	1.99
	(0.090)	(0.102)	(0.305)	(0.140)	
Log father's years schooling	-0.063	-0.139	-0.196	-0.256*	2.08
	(0.134)	(0.148)	(0.214)	(0.150)	
Log per capita expenditures	0.341***	0.146	0.401	0.674***	8.13
	(0.110)	(0.120)	(0.865)	(0.226)	
Buddhist	-0.145	-0.120	-0.121	-0.122	0.25
	(0.116)	(0.150)	(0.146)	(0.143)	
Catholic	-0.061	0.070	0.078	0.087	0.07
	(0.185)	(0.172)	(0.170)	(0.169)	
Protestant	-0.641***	-0.806***	-0.842***	-0.881***	0.01
	(0.211)	(0.202)	(0.174)	(0.132)	
Other religion	-0.574*	-0.696**	-0.648	-0.597	0.01
	(0.301)	(0.338)	(0.452)	(0.492)	
Chinese	0.857***	0.966***	0.990***	1.016***	0.06
	(0.306)	(0.313)	(0.325)	(0.328)	
Ethnic Minority	0.862	1.134	1.132	1.129	0.01
	(0.721)	(0.773)	(0.777)	(0.787)	
R^2	0.260	0.386	0.379	0.357	
Overidentification test (p-value)	-	-	0.499	0.608	
F-tests on excluded instruments	-	-	14.25	26.05	
Observations	469	469	469	469	

Notes: 1. Standard errors (adjusted for sample design) in parentheses.
2. Statistical significance at 10, 5 and 1 percent levels indicated by 1, 2 and 3 asterisks, respectively.
3. Instrumental variables for (1) of 2SLSFE are: irrigated annual cropland, unirrigated annual cropland, perennial cropland, and water surface; income from social funds, social subsidies, dowries, inheritances and lottery winnings; and the existence of relatives in other Asian countries and in non-Asian countries. The estimates in (2) add per capita household income as an instrument.

Table 6: **Determinants of Child Malnutrition in Rural Areas, 1997-98**

	OLS	Fixed Effects	2SLSFE (1)	2SLSFE (2)	Means
Constant	-12.715***	-	-	-	1.00
	(1.862)				
Age (months)	-0.205***	-0.202***	-0.202***	-0.203***	32.3
	(0.022)	(0.022)	(0.023)	(0.022)	
Age^2	0.006***	0.006***	0.006***	0.006***	-
	(0.001)	(0.001)	(0.001)	(0.001)	
Age^3	-0.00005***	-0.00005***	-0.00005***	-0.00005***	-
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	
Mother's height (cm)	0.037***	0.039***	0.041***	0.083***	151.9
	(0.008)	(0.007)	(0.008)	(0.007)	
Mother's height missing	0.242	0.130	0.104	0.135	0.02
	(0.189)	(0.173)	(0.165)	(0.174)	
Father's height (cm)	0.035***	0.027***	0.029***	0.027***	161.8
	(0.009)	(0.009)	(0.009)	(0.010)	
Father's height missing	0.123	0.126	0.111	0.128	0.10
	(0.103)	(0.103)	(0.106)	(0.107)	
Female child	0.018	-0.003	-0.014	-0.001	0.49
	(0.068)	(0.067)	(0.071)	(0.070)	
Log mother's years schooling	-0.116	-0.104	-0.063	-0.122	1.61
	(0.073)	(0.073)	(0.093)	(0.071)	
Log father's years schooling	0.035	-0.006	0.042	-0.016	1.78
	(0.082)	(0.082)	(0.115)	(0.105)	
Log per capita expenditures	0.298***	0.134	-0.220	0.203	7.42
	(0.068)	(0.095)	(0.539)	(0.335)	
Buddhist	0.080	0.175	0.186*	0.173	0.15
	(0.093)	(0.108)	(0.111)	(0.108)	
Catholic	-0.170*	-0.223*	-0.196	-0.228*	0.12
	(0.098)	(0.129)	(0.131)	(0.124)	
Protestant	-0.269	-0.206	-0.184	-0.210	0.03
	(0.257)	(0.277)	(0.280)	(0.279)	
Other religion	-0.148	0.041	0.033	0.043	0.03
	(0.242)	(0.235)	(0.242)	(0.234)	
Chinese	-0.170	-0.096	0.055	-0.126	0.002
	(0.339)	(0.598)	(0.663)	(0.595)	
Ethnic Minority	-0.086	-0.078	-0.149	-0.064	0.22
	(0.127)	(0.158)	(0.193)	(0.179)	
R^2	0.215	0.326	0.320	0.326	
Overidentification test (p-value)	-	-	0.561	0.506	
F-tests on excluded instruments	-	-	13.54	14.54	
Observations	1672	1672	1672	1672	

Notes: 1. Standard errors (adjusted for sample design) in parentheses.
2. Statistical significance at 10, 5 and 1 percent levels indicated by 1, 2 and 3 asterisks, respectively.
3. Instrumental variables for (1) of 2SLSFE are: irrigated annual cropland, unirrigated annual cropland, perennial cropland, and water surface; income from social funds, social subsidies, dowries, inheritances and lottery winnings; and the existence of relatives in other Asian countries and in non-Asian countries. The estimates in (2) add per capita household income as an instrument.

Table 7: **Determinants of Child Malnutrition: Panel Data Estimates**

	Urban			Rural		
	OLS	**Fixed Effects**	**2SLSFE**	**OLS**	**Fixed Effects**	**2SLSFE**
Sex	0.033	0.032	-0.037	0.017	-0.003	0.004
	(0.329)	(0.345)	(0.395)	(0.157)	(0.147)	(0.147)
Age (months)	-0.059**	-0.067***	-0.054*	-0.083***	-0.086***	-0.087***
	(0.022)	(0.022)	(0.029)	(0.009)	(0.009)	(0.009)
Age^2	0.0009**	0.0010	0.0008	0.0011***	0.0011***	0.0011***
	(0.0004)	(0.0004)	(0.0005)	(0.0002)	(0.0002)	(0.0002)
Age^3	-0.000004*	-0.000004*	-0.000004	-0.000005***	-0.000005***	-0.000005***
	(0.000002)	(0.000002)	(0.000003)	(0.000001)	(0.000001)	(0.000001)
Log per capita expenditures	-0.016	-0.106	-0.939	0.004	-0.046	0.376
	(0.168)	(0.185)	(0.920)	(0.077)	(0.084)	(0.512)
R^2	0.068	0.239	0.178	0.138	0.240	0.226
Sample Size	237	237	237	1426	1426	1426

Notes: 1. Standard errors (adjusted for sample design) in parentheses.
2. Statistical significance at 10, 5 and 1 percent levels indicated by 1, 2 and 3 asterisks, respectively.
3. All variables were differenced for estimaton
4. Sample includes all panel households who had at least one child age 0-60 months in both surveys.

Table 8: Role of Economic Growth in Reducing Child Malnutrition

	Mean HAZ		Percent Stunted	
Actual Figures:	**Urban**	**Rural**	**Urban**	**Rural**
1992-93	-1.455	-2.009	33.2	53.2
1997-98	-0.895	-1.524	18.4	38.2
Change (over 5 years)	+0.560	+0.485	-14.8	-15.0
Estimates of change due to economic growth:				
OLS	0.199	0.083	-5.7	-3.0
	[0.344]	[0.133]		
FE	0.128	0.042	-3.3	-1.5
	[0.300]	[0.109]		
2SLS (1)	0.201	0.066	-6.6	-2.4
	[1.112]	[0.421]		
2SLS (2)	0.281	0.092	-9.0	-3.2
	[0.639]	[0.324]		
OLS (panel)	-0.008	0.001	+0.2	-0.0
	[0.156]	[0.041]		
FE (panel)	-0.051	-0.013	+2.3	+0.6
	[0.130]	[0.031]		
2SLS (panel)	-0.449	0.098	+15.0	-3.2
	[0.451]	[0.363]		

1. Cross-sectional estimates are based on the mean of the 1992-93 and 1997-98 estimates.
2. Increase in real expenditures per capita was 29.8% in rural areas and 61.3% in urban areas (GSO, 1999). This implies that the changes in log per capita expenditures were +0.261 in rural areas and +0.478 in urban areas.
3. Numbers in brackets are upper bounds of 95% confidence intervals.

Table 9: **Descriptive Statistics of Selected Community Variables**

Variable	Communities with Observants	Mean	Standard Dev.	Min.	Max.
Price of oral rehydration salts	146	1288	385	450	2,500
Price of ampicillin	152	4143	1112	700	8,000
Price of penicillin	151	2591	948	1000	8,000
Price of iron tablets	119	3409	5541	0	37,250
Price of Vitamin A	126	692	865	0	4,750
Price of paracetemol	151	1121	1101	0	9,000
Distance to prov. hospital (km)	154	38.6	33.4	0	180
Distance to state pharmacy (km)	144	6.1	12.1	0	100
Distance to priv. pharmacy (km)	146	3.1	7.8	0	50
Diarrhea is local health problem	156	0.46	-	-	-
Characteristics of comm. health cen:					
Lack of electricity	155	0.13	-	-	-
Lack of clean water	155	0.26	-	-	-
Lack sanitary toilet	155	0.34	-	-	-
Total equip. index	152	9.29	1.11	7	14
Price of ampicillin	135	4.07	5.40	0	50
Injection price	153	0.28	0.56	0	5
Oral rehydration salts price	150	1.41	1.12	1	5

Table 10: Impact of Community Health Services on Child Malnutrition in Rural Areas 1997-98

Age (months)	-0211***	-0.209***	-0.208***	-0.207***
	(0.024)	(0.024)	(0.025)	(0.025)
Age^2	0.006***	0.006***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Age^3	-0.00005***	-0.00005***	-0.00005***	-0.00005
	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Mother's height (cm)	0.035***	0.035***	0.035***	0.0036***
	(0.008)	(0.008)	(0.008)	(0.008)
Mother's height missing	0.150	0.127	0.110	0.160
	(0.219)	(0.219)	(0.108)	(0.208)
Father's height (cm)	0.032***	0.032***	0.031***	0.031***
	(0.010)	(0.010)	(0.010)	(0.010)
Father's height missing	0.094	0.099	0.110	0.092
	(0.107)	(0.107)	(0.108)	(0.109)
Female child	-0.030	-0.031	-0.023	-0.033
	(0.068)	(0.068)	(0.069)	(0.071)
Log mother's years schooling	-0.202***	-0.185***	-0.178**	-0.181**
	(0.069)	(0.070)	(0.0070)	(0.075)
Log father's years schooling	-0.002	0.000	-0.001	-0.002
	(0.085)	(0.084)	(0.083)	(0.088)
Log per capita expenditures	0.0259***	0.240***	0.232***	0.219***
	(0.074)	(0.078)	(0.080)	(0.083)
Buddhist	0.047	0.029	0.028	0.053
	(0.098)	(0.097)	(0.097)	(0.103)
Catholic	-0.233*	-0.213*	-0.269**	-0.288***
	(0.124)	(0.116)	(0.108)	(0.109)
Protestant	-0.357*	-0.278	-0.343	-0.346
	(0.195)	(0.204)	(0.221)	(0.217)
Other religion	-0.330	-0.364	-0.387	-0.178
	(0.227)	(0.231)	(0.247)	(0.184)
Chinese	-0.946***	-0.971***	-0.894***	-0.959***
	(0.112)	(0.110)	(0.106)	(0.113)
Ethnic Minority	-0.066	-0.036	-0.007	-0.016
	(0.134)	(0.135)	(0.132)	(0.136)
Distance Prov. Hosp.	-0.0023*	-0.0016	-0.0022	-0.0018
	(0.0012)	(0.0015)	(0.0016)	(0.0017)
Distance State Pharm.	-0.0022	-0.0020	-0.0018	-0.0024
	(0.0019)	(0.0020)	(0.0021)	(0.0021)
Distance Priv. Phar.	-0.0158***	-0.0136**	-0.0138**	-0.0133**
	(0.0053)	(0.0062)	(0.0062)	(0.0063)
Commune health center variable				
(a) lacks electricity	-	-0.104	-0.028	-0.052
		(0.165)	(0.173)	(0.166)
(b) unsanitary toilets	-	-0.151*	-0.142	-0.192**
		(0.087)	(0.089)	(0.091)
(c) equipment index	-	-	0.051	0.052
			(0.041)	(0.038)
(d) availability of oral rehydration salts	-	-	-	0.110**
			-	(0.048)
Sample	1446	1443	1411	1342
R^2	0.247	0.250	0.252	0.261

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